Blue and Fin Whale Habitat Modeling from Long-Term Year-Round Passive Acoustic Data from the Southern California Bight

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LONG-TERM GOALS

During this project, we will develop predicitive, year-round habitat models of the presence of calling blue and fin whales in the Southern California Bight, to facilitate Navy's opeational needs in this area.

OBJECTIVES

The primary objective of this research is to develop predictive, year-round habitat models of the presence of calling blue and fin whales in the Southern California Bight. We will also investigate the scales over which blue and fin whales respond to their environment to better understand the functionality of the predictive relationships in those models. We will base our models on the available passive acoustic and remotely sensed data, as well as the lunar and buoy data available for the SCB.

APPROACH

Passive acoustic data have been collected using High-frequency Acoustic Recording Packages (HARPs) deployed at 16 locations in the Southern California Bight (Figure 1). We will use automatic detectors to determine year-round presence of blue and fin whale calls in the area of the Southern California Bight between 32° and 34° 20' N from passive acoustic recordings collected between 2005 and 2011. This temporally extensive data set will allow us to investigate the effects of environmental, remotely sensed variables, as well as a number of temporal variables, such as time-of-day, month, season, and year on the distribution of these two species of whales. Such temporal variables are rarely included into models based exclusively on visual survey data thus our models are likely to offer new insights on the importance of these time scales on blue and fin whale habitat preferences.

Environmental variables will be obtained from remotely sensed data and will include sea surface temperature (SST), salinity, sea surface height, and chlorophyll *a* concentration. These data are avaialble on similar temporal (daily, weekly, monthly) and spatial scales (1 to hundreds of km) as passive acoustic whale monitoring. Data that are contemporaneous spatially and temporally for each deployment location and period will be downloaded using the database tools developed by M. Roch (ONR grant N000141110697). In addition to the remotely sensed data, we will use SST and chlorophyll *a* data to construct fronts in the region. We will also use the solar and lunar cycle data

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from the U.S. Naval Observatory, and weather buoy data (e.g. wave height, wind) collected through the National Data Buoy Center for the parts of the SCB region with HARP deployments.

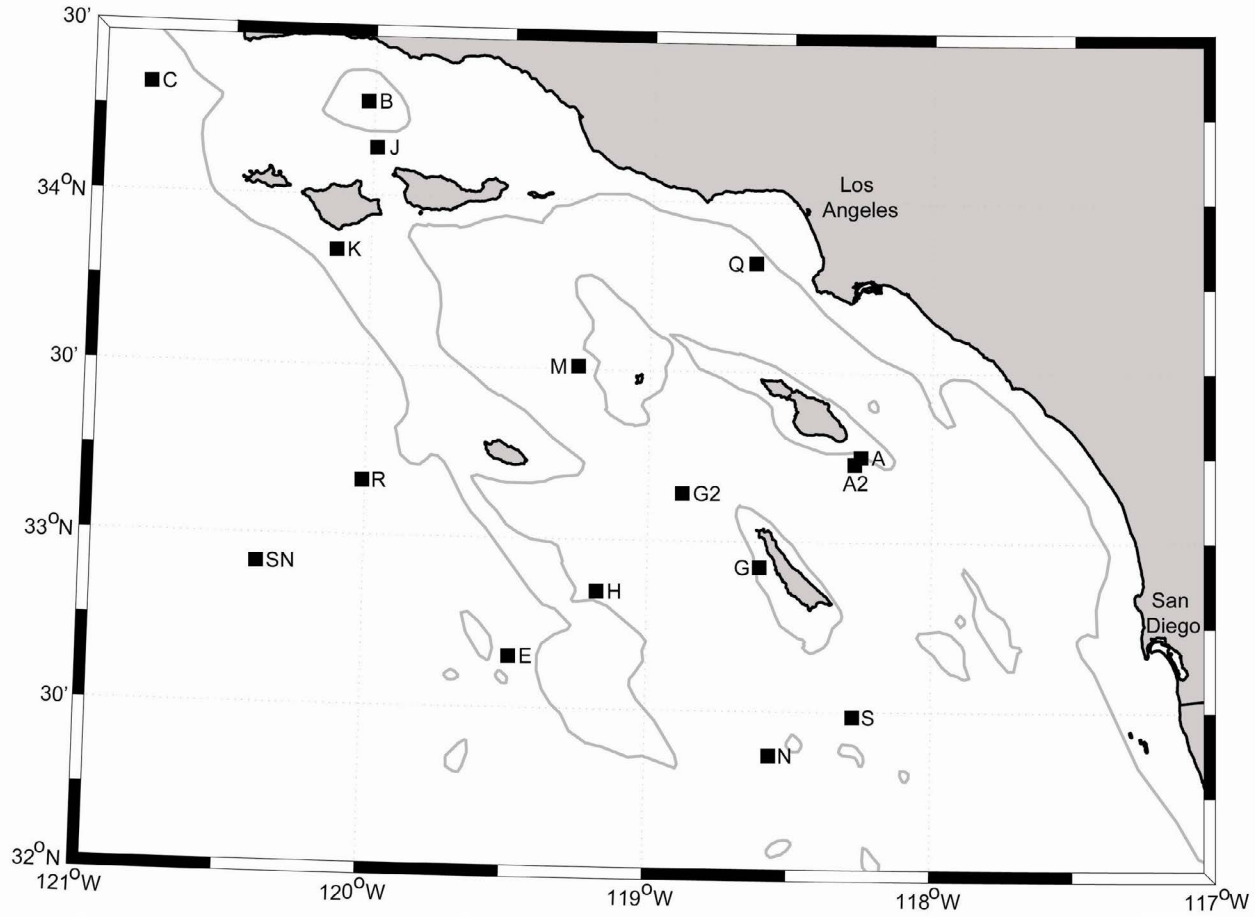

Figure 1. HARP deployment locations (black squares) throughout the Southern California Bight between 2005 and 2011; data from these locations will be available for habitat modeling in this study. Light grey line denotes the 500 m bathymetry contour.

When comparing acoustic and remotely sensed data, and for meaningful habitat modeling, one of the major problems is determining the appropriate spatial scale on which to conduct the analysis. On the one hand, the choice of scale is limited by the spatial resolution in collected data, but in theory, it should also be driven by the scale of the whale's response to the environment. We will explore the effect of different spatial scales on blue and fin whale habitat models further in this study. To use call detections for such an analysis, however, we first must determine the scale (range) over which blue and fin whale calls can be detected. We will develop propagation models for areas around each of the HARP deployment locations to investigate the characteristics of propagation loss in the area. We will use these models to estimate propagation loss at low frequencies over different spatial scales of interest (small-scale, meso-scale, and large-scale) and over four seasons (spring, summer, fall, and winter).

We will use the information from propagation loss modeling to fine-tune our automatic detectors and thus create presence indices for loud (nearby), intermediate, and quiet (distant) calls. By obtaining three sets of detections for each call corresponding to the presence of calling whales in three different

areas around each HARP, we will be able to investigate the effects of range on the functional models affecting blue and fin whale distribution.

First, all data will be spatially and temporally aligned to compare the presence of blue and fin whale calls with the environmental. Next, we will use a generalized additive modeling (GAM) framework to identify the most significant habitat variables that affect the presence of these whales in the Southern California Bight. Independent environmental variables that will be used for selection in the models include: SST, sea surface height, chlorophyll *a* concentration, distance to SST and chlorophyll *a* fronts, distance to shore, depth, tidal level, and, when available, wave height and wind speed. The advantage of this method over the habitat models that have been developed from more traditional ship-based visual surveys is that passive acoustic data provide a much finer temporal resolution. Therefore, we will also be able to investigate the effects of temporal variables, such as time-of-day, month, and year on the distribution of blue and fin whales. We will construct separate GAMs for different call types, detection ranges (small-scale, meso-scale, and large-scale), and seasons.

We plan to include the metadata for all detected calls (location, time, and type of call) and our final, best habitat models into the Ocean Biogeographic Information System – Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) database for access by the larger community. Work on detector development and implementation, as well as habitat modeling, will be headed by Dr. Ana Širović.

WORK COMPLETED

This grant was awarded in July 2012 and the work on the project has just started. We are in the process of finalizing decimation of all data sets that will be used for the model development; we have processed approximately 55% of the data sets thus far. We have also started working on the development and implementation of automated detectors for two types of blue whale and one type of fin whale call.

RESULTS

The grant was awarded in July 2012, thus there are no significant results to report at this point.

IMPACT/APPLICATIONS

Understanding the distribution of cetaceans over space and time is relevant for the Navy's operational needs in Southern California. Unlike visual observations that generally provide limited temporal resolution, passive acoustic methods have the potential to resolve changes in the distribution of marine mammals on both short and long-term temporal scales. Therefore, passive acoustic methods have the potential to be used to improve our understanding of the dynamics of habitat use and population distributions of vocalizing cetaceans. The proposed development of spatially-explicit habitat models for calling blue and fin whales, once completed, will enhance the ability of the Navy to predict blue and fin whale occurrence in this SCB region year-round. Incorporation of the models to the OBIS-SEAMAP environment will improve their utility for other users.

RELATED PROJECTS

During this project, we will be using the database developed under the project "Acoustic metadata management and transparent access to networked oceanographic data sets" (ONR grant N000141110697, PI: M. Roch) for data management as well as easy access to oceanographic data needed for habitat modeling.